REPLY COMMENTS OF WILLIAM E. TAYLOR, PH.D.
JANUARY 24, 2000

I. INTRODUCTION

1. My name is William E. Taylor. I am a Senior Vice President of National Economic Research Associates, Inc. (NERA), head of its telecommunications economics practice and head of its Cambridge office. I filed direct comments in this Docket on behalf of the United States Telecom Association ("USTA") on January 7, 2000 and have been asked to reply to some of the economic issues raised by other parties. In particular, two major claims that I address are the assertions:

   - that an interstate-only TFP methodology can be developed in an economically meaningful and defensible manner, and
   - that a study by Strategic Policy Research ("SPR") can be used to develop a measure for the impact that eliminating earnings sharing will have on price-cap LEC productivity.

2. On the contrary, after more than ten years of price cap analysis, debate and decision making, there is one fact that should be clear to all parties by now: there is no economically meaningful definition of an interstate-only X-factor and therefore there is no defensible methodology to estimate it. AT&T's proposal is simply a regurgitation of the Historical Price Method, and it works no better the second time around. Try as it might, AT&T will never be able to produce an economically respectable productivity study for a subset of services in an industry like telecommunications where the production process is not separable by service. AT&T's attempt here relies on the trick of assuming that revenues and costs for interstate services are equal in every period. There is no basis for such an assumption, and without it AT&T's entire house of cards come crashing down. As I demonstrate below and in the Appendix, AT&T's effort was doomed from the start because there is no interstate X-factor to measure.

3. In addition, AT&T and Ad Hoc present several flawed methods that attempt to estimate the effect that the elimination of earnings sharing has on price cap LEC productivity. Their conclusions are incorrect because (i) they are based on the unsupported and erroneous assumption that changes in efficiency incentives give rise to proportional changes in measured productivity growth and (ii) they are based on flawed measures of productivity growth in the post price cap period.

4. Finally, I address several additional topics: Ad Hoc's cost of capital sensitivity analysis, its use of minutes as a measure of local output and its Hedonic adjustment argument and AT&T's 1997 reinitialization recommendation to the Staff Imputed X-Study.

5. Apart from the economic errors made by the parties in this proceeding (in methodology and practice), the implicit motivation for the proposed changes (as well as the proposed changes raised in the Commission's recent Access Reform Further Notice of Proposed Rulemaking) is flawed—namely the notion that the price cap LECs' earnings have been "excessive." I have consistently pointed out the flaws that underlie the calculation of interstate earnings. However, as discussed in the Reply Comments of USTA, even the flawed interstate earnings which are cited by the parties do not support the proposition that the price-cap LECs' earnings are excessive.[1] Specifically, USTA concludes that the BOC industry average after-tax interstate profit margin has remained at or slightly below the ROR era levels through 1998. The USTA analysis shows that increases in earnings per dollar of investment are associated with higher levels of revenue per dollar of investment and constant earnings per dollar of revenue. LEC efficiency has increased, not their profit margin. And, rate reductions under price caps have exceeded $6 billion. This combination vindicates the Commission's price cap plan and is a sign of success, not failure. As the Commission stated in the *1997 Price Cap Performance Review* (at 2):

> Price cap regulation is intended to encourage growth in productivity by permitting incumbent LECs that increase their productivity to earn higher

[1] I made a similar point in the recent Access Reform Notice of Proposed Rulemaking, where I stated that earnings of price cap LECs have not performed as well as the average industrial firm while—at the same time—the LECs' customers have done considerably better than average customers as a result of price cap regulation. See Comments of William E. Taylor, October 29, 1999, CC Docket 96-262.

> profits, while at the same time ensuring that interstate access customers share in the benefits of productivity growth in the form of lower rates. The price cap formula was designed to ensure that "[b]oth carriers and customers will be better off" under price cap regulation.

Clearly, the Commission's objectives are being met. Price cap customers are better off while increases in LEC earnings are due to more efficient use of resources.

II. AT&T'S INTERSTATE-ONLY TFP METHODOLOGY DOES NOT ADD UP

6. AT&T presents a study that purports to find the elusive solution that has been evading the Commission since the beginning of price cap regulation: an economically defensible measure of the growth of productivity for the interstate services of a local exchange carrier.[2] But like a wolf in sheep's clothing, AT&T's methodology is not what it appears to be. Had AT&T remembered the economic arguments developed in the beginning of price cap regulation, it would have recalled that this approach has already been raised, refuted and rejected because it embodies two incorrect assumptions: (i) that interstate total factor productivity growth is defined and (ii) that interstate revenues and costs can be meaningfully measured.

7. The method used by AT&T in its Appendix A is, as its author states, based on a paper presented at a recent economics conference.[3] In the paper, however, the author is more candid about his proposed X-factor and LEC productivity growth:

> Finally, it is worth reiterating that there is no need to explicitly estimate productivity growth to determine the X-Factor...The fact that the X-Factor is often called a productivity factor does not make it necessary to measure productivity explicitly.[4]

[2] AT&T Comments Appendix A, "Direct Calculation of Interstate-Only X-Factors Based on Option 2 Methodology," Stephen Friedlandler.

[3] Stephen Friedlander, "The Use of Productivity Studies in Price Cap Regulation: What do the FCC's X-factor Calculations Really Measure?" 18th Annual Conference of the Center for Research in Regulated Industries, Rutgers University, May 27, 1999, ("Friedlander Rutgers paper").

[4] *Ibid*, at 13.

AT&T's study does not result in a measure of productivity growth at all. Yet AT&T's Comments are cast as having finally found what the Commission has been searching for all along—an economically defensible measure of interstate-only productivity.[5] Nothing is further from the case.

8. AT&T's study simply rediscovers the so-called "indirect" method for estimating TFP growth which was known as the Historical Price Method in FCC price cap terminology. This method uses the economic duality between prices and quantities to measure productivity growth as the difference between changes in input and output prices rather than the difference between changes in output and input quantities. AT&T's Appendix A begins with the observation that the economically justified X-factor is derived by summing the difference between US and LEC TFP growth and US and LEC input price growth. After several calculations, AT&T arrives at the following expression for X:[6]

(1) $$X = \%\Delta Q_{Lec} - \%\Delta REV_{Lec} - \%\Delta TFP_{US} + \%\Delta IP_{US}$$

The first two terms are equivalent to a LEC-specific output price index while the last two terms are equal to national inflation (GDPPI), as recognized in Appendix A. As I show in Appendix I, this expression is nothing more than the indirect method for calculating the X-factor. Up to this point, AT&T's intuition is correct. Its mistake, however, occurs when it assumes that it can apply equation (1) above to the LECs' interstate–only output and revenue to get an economically valid measure of interstate-only TFP growth. This assumption is economically incorrect and simply cannot be done.

9. Productivity growth can be calculated from either the differential rates of growth of input and output quantities or prices.[7] However, measurements of the change in TFP by either

[5] "Another virtue of the Option 2 methodology is that it can easily be modified to permit the Commission to base the X-factor on estimates of productivity gains in *interstate* services, rather than total company productivity...As a matter of both law and policy, the X-factor should be based, if possible, on estimates of productivity gains for interstate services." [AT&T Comments at 8].

[6] AT&T Comments, Appendix A, equation (7).

[7] D. W. Jorgenson observes that: "An index of total factor productivity may be computed either from quantity indexes of total output and total input or from the corresponding price indexes." D. W. Jorgenson, "The Embodiment Hypothesis," *Journal of Political Economy*, Vol. LXXIV, February 1966.

the price or quantity method requires the assumption that the value of the firm's input equal the value of the firm's output in each period—or at least that the data are adjusted so that this identity holds approximately in the historical period. These basic facts from the economic theory of duality imply that the apparent ability of the historical price method to produce a productivity offset or a measure of productivity growth *for an individual service* or for interstate services is illusory. When output price data for interstate services are adjusted to keep earnings constant across the historical period, accounting costs and revenues must be assigned to individual services—and therein lies AT&T's fundamental economic error. AT&T attempts to mask this crucial fact by simply stating (Appendix A at 6), almost as an afterthought that:

> In order to use equations (7) or (9) to calculate interstate X-factors, the revenue data needs to be *adjusted* to remove earnings in excess of the LECs' cost of capital [emphasis added].

AT&T cannot get around the fact that costs and revenues must be jurisdictionally separated in order to arrive at its results. As the author of Appendix A acknowledges:

> Once it is recognized that the X-Factor is determined on the basis of growth in revenue per unit, and not growth in total factor productivity, the LEC argument is rendered moot. There is no reason why the FCC can not focus on the trend in interstate revenue (*or costs allocated to interstate via the separations process*) per unit of output, as it did when previously prescribing X-Factors via the *Historical Price Method.* [emphasis added, footnotes omitted].[8]

10. No reason, indeed. AT&T's flawed logic is: if you can't measure interstate TFP growth, base X on the trend in costs allocated to interstate via the separations process. The AT&T approach is nothing more than the Historical Price Method which, as described below, the Commission has already rejected. It is not what AT&T claims in its comments (at 8)—an X-factor based on productivity gains in interstate services. AT&T cannot escape the fundamental economic problem that what makes an interstate-only productivity calculation impossible is that the production function is not separable. In the presence of shared fixed and common costs, one cannot assign costs and revenues to the interstate and intrastate

[8] Friedlander Rutgers paper at 12.

jurisdiction in any economically meaningful way so that equations (7) or (9) provide a valid measure of X based on interstate-only productivity growth. Using the Historical Price Method to estimate productivity for specific services erroneously assigns a portion of the LECs' fixed costs to interstate services and derives an arbitrary estimate of interstate TFP growth.

11. Moreover, in contrast to AT&T's claim (at 2), the problem is **not** simply one of "separating interstate and intrastate costs for the TFP calculations." The problem is that TFP growth for interstate services **is not defined** for a multiproduct firm whose production function is not separable. What this phrase means is that changes in unit costs of interstate access services—which in competitive markets would drive changes in prices which the price cap plan attempts to emulate—depend on changes in both interstate and intrastate demand quantities, interstate and intrastate variable costs and the shared fixed and common costs that cannot be assigned. Absent separability of the production function, suppose there were no shared fixed and common costs—so that all costs could be (meaningfully) jurisdictionally assigned—and suppose further that output quantities could be unambiguously separated between interstate and intrastate services. As I described in my previous comments in this docket, even in this best case, there would still be no TFP growth defined for interstate services. The change in unit cost of an interstate minute would depend on the growth of interstate as well as intrastate minutes of use. Thus, in a competitive market, we would not expect the price of an intrastate minute to fall more slowly than the price of an interstate minute simply because intrastate output growth was slower than interstate output growth. In the simple case where unit costs fall with the growth of minutes (irrespective of jurisdiction), we cannot use the difference in growth rates of interstate output and input to tell us anything about what would happen to interstate unit costs or interstate prices.

12. What AT&T purports to measure doesn't exist. However, as one might examine a purported photograph of an alien space ship and wonder what it was, one might well ask how AT&T has managed to measure a non-existent interstate X without jurisdictionally

separating revenues and costs.[9] As shown below in Appendix I, the mathematical sleight of hand is perpetrated in an underlying assumption of the model: that revenues and costs for interstate services are equal in every period. Only under the assumption that interstate revenues and costs are well-defined and equal has AT&T managed to find this black cat in the dark room in which there is no cat.

13. In Appendix I, I derive the indirect method of calculating the change in TFP and the resulting X-factor for the regulated firm. Two results stand out. The first is that the end result is, in essence, the same as AT&T's equation (1) in Appendix A. The second, and more important result is that the underlying assumption that is needed in order for the identity to hold is that the *total company's* revenue just recover its costs so that there is zero economic profit. Applying the method in Appendix I to a subset of services or an individual service is incorrect if the production function is not separable in those services. There is no escaping the fact that the indirect approach must be undertaken at the level of the total firm rather than for interstate or individual services.

14. Moreover, AT&T's method (which is nothing more than the indirect method) relies on the premise that the trend in revenue per unit of measured output is an accurate measure of the trend in unit costs. However, in the previously cited paper, the author casts doubt on this important assumption. After identifying certain concerns with the output index used by the Commission (and on which the author relies) he states:

> These considerations suggest that the trend in revenue per unit of measured output can *deviate substantially* from the trend in unit costs.[10] [emphasis added]

AT&T's proposal to base X on the change in unit revenues makes no sense if the change in unit revenues differs from the change in unit costs.

15. Apart from the economic error of attempting to use the indirect method to estimate an interstate-only X-factor, there is another general weakness with the indirect method. While in theory, duality implies that TFP growth measured by quantities and prices will be the

[9] It has escaped no one's notice that these productivity debates are collectively classified as "X Files" in the industry.

same, violating any of the assumptions of the methods will not likely have the same effect on the two TFP growth measures. For example, TFP growth measured by quantities could differ markedly from TFP growth measured by prices if economic earnings vary from year to year during the historical period. If prices are adjusted in each period to keep measured economic earnings constant, errors in the adjustment would affect TFP as measured by prices more than TFP as measured by quantities. Using the historical price method, TFP growth is calculated from changes in prices (i.e., the difference between the rates of growth of input and output prices). Using the quantity method, prices enter TFP growth calculation only as part of the revenue and expenditure weights used to calculate aggregate quantity indices of outputs and inputs and enter the calculation only as levels rather than annual changes. Thus, errors in measuring input or output prices (or adjusting prices to keep accounting earnings constant) have a larger effect on TFP growth as measured by price rather than quantity.

16. Indeed, possibly for this reason the Commission has already rejected the Historical Price Method in the *1997 Price Cap Performance Review* (¶ 23):

> We also decline to continue using the Historical Price Method developed in the LEC Price Cap Order. None of the commenters supports this approach. Furthermore, the Historical Price Method bases the X-Factor on historical trends in prices of telecommunications prices relative to the economy as a whole, and thus uses price changes as a surrogate for productivity growth. We find that TFP is a more accurate measure of LEC productivity because it is based on incumbent LECs' actual outputs and inputs. [footnotes omitted].

17. Finally, even ignoring AT&T's adjustments to historical revenues, the use of annual growth rates in revenues and output as an LEC output price index produces results that are inconsistent with the very design of price caps. When LECs are pricing at the cap, the difference between the change in its average prices as measured by the price cap mechanism and GDP-PI equals X. Therefore, apart from exogenous changes, historical observations of LEC output prices as determined by AT&T's methodology should closely reproduce the X factors that were in place during that period.

[10] Friedlander Rutgers paper at 12.

18. In fact, the method described in AT&T's Appendix A—equation 9 applied with actual, rather than adjusted revenue—produces values for what should be the mathematical equivalent of X that are considerably larger than the productivity targets that were in place. Table 1 shows these results (for both adjusted and unadjusted revenue). For example, in 1993, AT&T's approach (using actual rather than adjusted revenues) suggests that LECs reduced their interstate prices by about inflation less 9.8 percent, even though the X factor was only 3.3 percent or 4.3 percent during that period. Clearly, the price change predicted using AT&T's methodology is different from the price change that occurred using the X-factor measure in place at the time.

19. How can this be? The answer must be that the price index used in the price cap mechanism must be fundamentally different than the price index implied by AT&T's approach. Thus, because the two indices obviously measure different things,[11] rates of change from one index tell you nothing about how the other index should change. This "apples and oranges" difference in output price indices completely invalidates AT&T's method, even before the erroneous rate-of-return adjustments to revenues are performed.

Table 1: "Historical X" Using AT&T's method[12]

Year	Historical X using Adjusted Revenue (%)	Historical X using Unadjusted Revenue (%)	X-Factor(s) (%)
1986	.01	.01	
1987	11.33	11.33	
1988	12.65	12.65	
1989	10.41	10.41	
1990	20.31	17.06	
1991	12.23	13.38	3.3 – 4.3
1992	10.00	6.77	3.3 – 4.3
1993	12.17	9.82	3.3 – 4.3
1994	6.51	6.26	3.3 – 4.3

[11] For example, AT&T's index most likely captures both price changes and shifts in demand to alternatives with lower unit price. Consider the special access component to interstate output and revenue. AT&T's approach implies an over 10-fold reduction in the price per special access line from 1985 to 1998. This was undoubtedly a combination of some price reductions in special access rate elements and shifts to higher capacity facilities, which have lower per-line rates.

[12] The data in the table are generated by applying equation 9 in AT&T's Appendix A. Data for interstate revenue come from AT&T Appendix A-2 and data for interstate output come from 1999 Staff study Table B-4.

1995	9.12	8.62	4.0 – 5.3
1996	9.07	7.11	4.0 – 5.3
1997	10.22	9.46	6.5
1998	2.57	2.44	6.5

III. AT&T AND AD HOC'S ARGUMENTS REGARDING THE CPD ARE FLAWED

20. In the *1997 Price Cap Performance Review*, the Commission decided to retain a CPD of 0.5 percent in the X factor to offset productivity growth stemming from the elimination of sharing requirements. In remanding this issue to the Commission, the Court questioned the Commission's justification for the CPD, citing the Commission's failure to tie the CPD to a specific productivity increase that could reasonably be expected from the elimination of sharing.

21. In my initial comments [at 27] I argued that while it is certainly plausible that the elimination of the sharing requirement from a price cap plan might—all else equal—lead to an increase in a firm's efficiency incentives, as a factual matter consumers have already partly benefited from the increased efficiency resulting from the elimination of the sharing requirements.[13] Continuing to include a CPD would effectively double-count the benefits of the elimination of sharing and, as a result, defeat the original purpose for eliminating sharing in the first place. Therefore, regardless of the CPD estimates provided by Ad Hoc, AT&T or any party, the effect that eliminating sharing has on productivity is to some extent already being incorporated in the Commission's current X-factor and even more so if the Commission revises the X-factor by using data up to 1998.

22. However, even if AT&T and Ad Hoc have a basis to claim (which they do not) that the sharing impact is not already partly taken into account, they both propose flawed methods to estimate the effect that the elimination of earnings sharing has on price cap LEC

[13] As described in my initial comments [at 28], in the original 1990 LEC Price Cap Order the Commission provided various options for price cap LECs to choose higher X-factors in return for less stringent earnings requirements. In 1995 the Commission permitted the price cap LECs to choose an option that provided for no earnings sharing and the vast majority of price cap LECs selected this option. Ultimately in 1997, the Commission eliminated sharing altogether. As a result, the price cap LECs have experienced at least some of the incentives benefits from elimination or reduction of sharing since as early as 1991.

productivity.[14] The methodology that AT&T and Ad Hoc highlight and primarily rely upon is based on a study by SPR on behalf of Southwestern Bell in the 1994 Price Cap Performance Review.[15] The SPR study developed a method for measuring the efficiency incentives embodied in price-cap plans of various durations. From the SPR study, AT&T and Ad Hoc derive different estimates of the degree to which changes in incentives arising from the elimination of earnings sharing are greater than changes in incentives arising from the movement from rate of return ("ROR") regulation to price cap regulation with earnings sharing. There are three major problems with the conclusions that AT&T and Ad Hoc derive from the SPR study. First, as I describe below in detail, AT&T and Ad Hoc misinterpret the SPR study by equating changes in incentives to changes in productivity growth. While changes in incentives can lead to changes in productivity growth, there is no evidence—in the SPR Study or elsewhere—that a 10 percent increase in incentives leads to a 10 percent increase in productivity growth. Second, the SPR study overestimates the efficiency incentives under ROR regulation thereby underestimating the change in incentives from adopting price cap with sharing. Third, the SPR study likely underestimates the efficiency incentives under a 50/50 sharing plan, thus further underestimating the change from adopting price cap with sharing. These errors lead to incorrect estimates of the impact of eliminating sharing on productivity. And when combined with flawed measures of the productivity impact resulting from eliminating ROR regulation, their conclusions become economically meaningless.

A. Changes in incentives do not equate to changes in productivity growth.

23. The fundamental mistake made by AT&T and Ad Hoc is that they equate changes in price cap LEC efficiency *incentives* estimated in the SPR study to changes in price cap LEC *productivity*.[16] Logically, this does not follow nor does it follow as a matter of economic theory.

[14] See AT&T Comments Appendix C and Ad Hoc Comments pp 18-29.

[15] See Attachment to Comments of Southwestern Bell Telephone Company, CC Docket 94-1, May 1994.

[16] AT&T makes this assumption explicitly: "If we further assume that the LEC's potential productivity gain, X, is a linear function of the incentive for efficiency, I, ..." [Appendix C at 2].

24. The SPR study develops a methodology for measuring the efficiency *incentives* embodied in price-cap plans of various duration, which it defines as the net present value to the regulated firm of an investment that increases annual profits by $1. As discussed below, AT&T and Ad Hoc use the SPR study to derive different estimates of the degree to which changes in incentives arising from the elimination of earnings sharing are greater than changes in incentives arising from the movement from rate of return ("ROR") regulation to price cap regulation with earnings sharing. AT&T predicts that the change in incentives is 3 times as great while Ad Hoc predicts it is approximately 4.25 times as great. They then incredibly assert that the change in productivity growth will be 3 times (AT&T) or 4.25 times (Ad Hoc) as great because of a change to pure price cap regulation compared with a change to price cap regulation with sharing.

25. Assume for the moment that SPR's methodology is for the most part correct and properly applied by AT&T and Ad Hoc.[17] AT&T and Ad Hoc's appalling error is their assumption that changes in efficiency incentives equate to proportional changes in measured productivity growth.

26. Productivity growth is driven by many factors not just changes in incentives. These factors include changes in consumer demand growth, consumer income, tastes and preferences, changes in market conditions in the factor markets and changes in technology. While the desire or incentive to increase productivity growth certainly has a positive impact on the productivity growth achieved, other factors surely influence these gains. And even if these factors could be held constant, there is no reason to think that doubling the incentive to make profits will double the growth of total factor productivity.

27. A change in incentives facing an economic agent does not necessarily equate to a proportional change in the behavior that the incentive is intended to influence. For example:

[17] Below, I describe several problems with AT&T's and Ad Hoc's use of the SPR Study results which bias upward their derived estimates of the CPD.

- Some presidential hopeful in New Hampshire promises to cut the marginal income tax rate in half. Should he be elected and keep that promise, we will all have an incentive to work more hours. But not necessarily twice as many or even 20 percent as many.[18]

- If Massachusetts doubled the fine for speeding, would the number of cars speeding fall in half? Would people drive half as fast?

- A mutual fund manager's compensation might be proportional to the amount by which she beats the S&P 500. Doubling the amount she keeps for each point above the S&P 500 would encourage her to work more hours, pick better stocks and increase the returns for her fund, but none of those measures of success would necessarily double in response to the change in incentives.

- A running back in professional football gained 1000 yards last year and received a bonus of $1000 per yard. If his bonus were increased to $4000 per yard this season, his incentive would increase by a factor of 4, but we would not necessarily expect him to run for 4000 yards.

For these reasons, AT&T and Ad Hoc's estimates of the CPD based on the SPR Study are nonsense. With no evidence and no support from the SPR Study, they equate changes in incentives with proportional changes in the outcome that those incentives are attempting to influence, which in this case is productivity growth for price cap LECs. An increase in incentives will increase average productivity growth—all else equal—but there is no evidence in the SPR Study that even attempts to link the change in incentives with a corresponding change in TFP growth for the regulated firm.

B. AT&T and Ad Hoc misuse the relative efficiency gains from eliminating sharing reported in the SPR Study.

28. AT&T uses SPR's efficiency estimates to arrive at the conclusion that the change from a price cap system with sharing to one without sharing should ultimately produce a larger productivity increases (about three times) than the productivity change from the old ROR system to price caps with sharing. Ad Hoc, using a slightly different approach, arrives at 4.25 as the appropriate number. Both of their results are driven by the observation that the

[18] If the current marginal tax rate of 30 percent were cut to 15 percent, an individual would keep 85 rather than 70 cents of a marginal dollar of income. In the language of the SPR study, this change would amount to a 20 percent increase in incentives, but there is no reason to believe taxpayers would work 20 percent more hours.

SPR study predicts that the efficiency incentives under ROR regulation with a one year lag are about 14 percent of the efficiency incentives that exist in unregulated competitive markets. The SPR study predicts that the efficiency incentives under a four year price cap regulation plan with 50/50 sharing are about 18 percent of the efficiency incentives that exist in unregulated competitive markets. Finally, the SPR study predicts that the efficiency incentives under a four year pure price cap plan are about 35 percent of the efficiency incentives that exist in unregulated competitive markets. Table 2 below restates these conclusions of the SPR Study.

Table 2: Efficiency Incentives Relative to Unregulated Market (%)

Term of Plan (Years)	Hybrid Price Cap With a 50/50 Sharing	Pure Price Caps	Rate of Return 1 Year Lag
1	8	14	14
2	11	21	14
3	15	29	14
4	18	35	14
5	22	42	14
6	25	49	14
7	29	55	14
8	32	62	14
9	35	67	14
10	37	71	14

Source: SPR study (pp. 21-23)

29. Several characteristics of the SPR model are evident in Table 2. First, the relative efficiency incentives under pure price caps are generally about double those under price cap regulation with 50/50 sharing. This relationship makes intuitive sense because for every dollar given back under a 50/50 sharing plan the firm would get to keep approximately two dollars under a pure price cap plan. Second, the efficiency incentives for 50/50 sharing relative to rate of return regulation are quite low for plans of short duration because—under rate of return regulation in the SPR Study—the firm never gives back earnings retrospectively, and that effect dominates for sharing plans of short duration. Third, the relative efficiency incentive of rate of return regulation (with a one year lag) is simply given by the relative efficiency incentive of a one-year pure price cap plan.

30. A serious problem with the use AT&T and Ad Hoc make of the SPR Study is that the reduction in efficiency incentives—for price cap purposes—from adopting a regulatory plan with sharing is greatly overstated in the Table 2. For its purposes, SPR models efficiency incentives as a function solely of efficiency gains. That is, price caps without sharing has roughly twice the efficiency incentives as price caps with 50/50 sharing because—for firms in the sharing range—a firm without sharing will keep roughly twice the incremental profit from a successful investment than a firm under price cap regulation with 50/50 sharing. In the current application to productivity growth, however, this model is inadequate: the consequences of potential losses—which are ignored in the SPR Study—are equally as important as the consequences of potential gains.

31. Suppose the firm is regulated by a 50/50 sharing plan and expects to be in the sharing range. Under these circumstances, its potential payoff if an investment is successful is half that of a firm under pure price cap regulation but so is its expected loss if the investment proves to be unsuccessful. Under 50/50 sharing, both incremental gains and losses are received and paid for in 50-cent dollars. Thus, the net effect of these changes in incentives on the amount of investment is ambiguous. For example, suppose a firm in the sharing range were contemplating an investment that would return $10 of incremental profit if successful and $10 of incremental loss if unsuccessful. If success and failure were equally likely, the expected gain to the firm from the investment would be exactly the same under 50/50 sharing and pure price cap regulation. In contrast, the SPR model would show twice the incentive to invest under pure price cap regulation compared with 50/50 sharing.

32. In addition, the SPR Study may overestimate the efficiency impact in practice of ROR with a one year lag. The SPR Study assumes that under ROR, a firm can earn above its required return and keep it all in subsequent periods. In the next rate case, prices would be adjusted so that in the *subsequent* period, the regulated firm would earn a competitive return with no adjustment for its overearnings in the prior period. Price cap regulation with sharing, on the hand, would require the firm to return 50 percent of the gains achieved within the sharing range and so, for very short plans, the efficiency incentives under price cap regulation with sharing would actually be lower than under ROR regulation. In the real world, application

of these types of regulation would not give rise to these strict differences. The effect of this problem in the application of the SPR Study would decrease AT&T's and Ad Hoc's estimates of the amount by which moving to a pure price cap system would result in increased incentives compared with a move to price cap regulation with sharing.

33. For example, assuming only a 10 percent overestimate of the efficiency incentives under ROR regulation would change AT&T's estimate from 3 (times the amount) to only 2.2 and Ad Hoc's estimate changes from 4.25 (times the amount) to only 3.1. Finally, when both the underestimation of price cap plans with sharing and the overestimation of ROR are modified by assuming a 10% error in both instances, it changes AT&T's estimate from 3 (times the amount) to only 1.3 and Ad Hoc's estimates change from 4.25 (times the amount) to only 2.1. Clearly, AT&T and Ad Hoc's estimates are not particularly robust and are sensitive to slight changes in value.[19]

C. AT&T and Ad Hoc overstate the CPD by using flawed measures of the productivity impact resulting from eliminating ROR regulation

34. The next step in AT&T and Ad Hoc's method is to estimate the amount by which productivity growth has changed after the movement from ROR regulation to price cap regulation with sharing. This amount is then multiplied by the degree to which incentives are greater from eliminating sharing than eliminating ROR regulation. Both AT&T and Ad Hoc use flawed measures of the productivity impact resulting from eliminating ROR regulation. Their general approach is to compare TFP growth during the 1986-1990 time period to TFP growth during the 1991-1995 or 1991-1998 time period. Ad Hoc and AT&T both use the Staff's 1999 TFP methodology with slight modifications. AT&T also uses their own interstate TFP study as well as the Staff's imputed X study.

35. The first problem with their methodology is that they fail to isolate the impact that eliminating ROR regulation has on price cap LEC productivity growth. Both AT&T and Ad Hoc use time series data from 1986 to 1995 or 1998 and take a simple difference in the

[19] For example, when both the underestimation of price cap plans with sharing and the overestimation of ROR are modified by assuming a 15% error in both instances, it changes AT&T's estimate from 3 (times the amount) to only .93 and Ad Hoc's estimates change from 4.25 (times the amount) to only 1.6.

average growth rates between 1986-1990 and 1991-1995/1998. Incredibly, they use this difference as the degree to which LEC productivity changed as a result of the elimination of ROR regulation. The difference in the averages can be explained by many factors and it is simply incorrect to ascribe these differences entirely to the elimination of ROR regulation. Productivity growth is a function of many additional factors such as utilization of labor, capital and material, changing market conditions including prices, customer taste and preferences, and income, and changes in technology. AT&T and Ad Hoc incorrectly give all the credit for changes in productivity during this time period to the change in regulation and this is simply incorrect. In the early years after divestiture, output growth resulting from increased subscriber line charges, lower carrier access and lower long distance prices probably caused significant one-time increases in TFP. By itself, the fact that subscriber line charges did not continue to rise in the 1990s resulted in slower TFP growth despite the change in regulation from rate of return to price caps in 1990. Similarly, since the implementation of the 1996 Telecommunications Act, the introduction of competition may have reduced LEC productivity growth, as output has grown less rapidly than without competition. Moreover, ILECs have been required to invest large amounts of money in market opening activities which may have the effect of increasing input quantities without a corresponding increase in output quantities.

36. In addition, AT&T and Ad Hoc use flawed measures of the degree to which LECs have increased productivity growth in the post-ROR era. AT&T uses its interstate-only productivity study and relies as well on the Staff's imputed X study. But for reasons mentioned above and in my Direct Comments, these methods are flawed and do not provide good measures of TFP changes. Even the measures used by AT&T and Ad Hoc do not show a statistically significant change in either the X-factor or the LEC TFP growth during the time periods of interest. Ad Hoc's X-factor series (Attachment 3) fails a difference of means test at the 5% level for the periods 1986-1990 and 1991-1995/8. AT&T's X-factor measures (Table A-4, A-6) and its measure of LEC TFP growth (Table A-8) also fail difference in means tests at the 5% level during the same periods.

37. In fact, a corrected data series supports results that are diametrically opposed to the proposition by AT&T and Ad Hoc. Specifically, USTA has attached a study by Professor Frank Gollop showing a decline in the X-factor during the post price cap period. The Commission's original 1997 TFP study also showed a decline, albeit slightly. Table 3 below summarizes the results.[20] It is by no means surprising that the X-factor can decrease in the post price cap period. Professor Gollop has found that there is no empirical support for the proposition that there would be an ever-increasing upward trend after the 1993-1995 period. He also found that the continuing trend reversal in labor inputs is a dominant source of the lower X-factors and that the productivity gains resulting from sizable labor force reductions in the early price-cap years could not be sustained in the long run.

Table 3: X-factor Averages pre and post price caps

Years	FCC 97[1]	USTA[2]	FCC 99 "Corrected"[3]	Average
(1) 1986-1990	5.24%	5.58%	5.51%	5.44%
(2) 1991-1995	5.22%	2.41%	6.13%	4.59%
(3) 1991-1998		3.29%	6.33%	4.81%
				Difference
(2)-(1)	-0.02%	-3.17%	0.62%	-.85%
(3)-(1)		-2.29%	0.82%	-.63%

[1] *1997 Price Cap Performance Review*, Chart D1 column G.
[2] *1999 FNPRM Price Cap Performance Review*, Professor Frank Gollop USTA Comments attachment 2, January 7, 2000, Appendix B, Chart D1 column G.
[3] *1999 FNPRM Price Cap Performance Review*, Staff Study Appendix B, Table B-12 column I.

D. LECs' choice of a 5.3% X-factor should not be used as a measure of likely productivity increases

38. AT&T argues (Appendix C) that the LECs' revealed valuation of the efficiency impact of the sharing mechanism is 1.3%, because, AT&T says, that when given the choice, most price-cap LECs chose the 5.3% X-factor with no sharing rather than the minimum 4.0% X-factor with full sharing. However, using the difference as a measure of likely productivity increase would be incorrect. The particular spread the Commission selected was designed to encourage carriers to select a high productivity target *on an annual basis*, and in the

[20] Indeed, the method described in AT&T's Appendix A produces the same conclusion. The data in Table 1 above show that the average of the "X factors" for the 1991-1995 period is –0.94 percentage points lower than the

process eliminate sharing as part of the price cap plan. There is a fundamental difference between proposing options for annual choices on the part of the RBOCs and *mandatory* elimination of sharing. The year-to-year productivity growth of an individual firm can vary considerably. With annual choice, the objective would be to provide an incentive to stretch to a higher level in otherwise above-average years. In contrast, a productivity target fixed over a number of years would have a correspondingly lower "stretch," because the variation in the average over a number of years is smaller than annual variations. Therefore, because the Commission's plan provided sharing as an annual option, its design provided no meaningful guidance for the establishment of a CPD. Further, sharing (or no sharing) was based on *accounting* rather than economic costs. Accordingly, the price-cap LEC's choices are, at best, only an indirect indicator of expected accounting performance, not expected productivity growth.

IV. OTHER ISSUES

A. AD Hoc's Cost of Capital Sensitivity Analysis Does not Refute the Fact that LEC Opportunity Costs are Different than Changes in Corporate Bond Rates or Government Securities

39. Ad Hoc claims to have performed sensitivity analyses of the TFP results using the other cost of capital price indices identified as alternatives in the 1999 Study. For example, Ad Hoc estimated TFP growth using Moody's Aaa corporate bond rate, the 10-year U.S. Treasury securities rate and the 30-year U.S. Treasury securities rate. Ad Hoc's analyses confirmed that TFP results using these alternative price index series were as indicated in the 1999 Staff Study.

40. Ad Hoc's analysis does not refute the central fact that using either Moody's Aaa, Moody's Baa, or 10-year and 30-year government securities as the cost of capital is improper because it does not adequately represent the market definition of the market cost of capital. The financial debt instruments used by Ad Hoc are not an appropriate measure of LEC

1986-1990 average. The corresponding difference between the 1991-1998 and 1986-1990 periods is –1.02 percentage points.

opportunity costs. Professors Frank Gollop and James H. Vander Weide present estimates of more appropriate cost of capital indices that should be used.[21] Ad Hoc's analysis does not refute any of the indices estimated by Professor Gollop or Vander Weide.

B. Minutes Should Not be Used to Calculate Local Service Output

41. In its 1999 Study, the FCC Staff uses minutes rather than calls in the local service component of total company output. Ad Hoc (at 8) supports the use of minutes as more appropriate than calls. Ad Hoc observes (at 10) that the ILECs have argued that an economically meaningful X-factor requires that the measure of output used in the model correspond to outputs driving revenue growth. Professor Gollop makes a somewhat similar but slightly different point in his Comments (at 20). He identifies lines rather than calls or minutes as superior and bases his decision on the following:

> The choice of an appropriate output measure must follow from the very purpose of the X-Factor as a public policy tool. Since X is used to cap prices and therefore, revenue, output in the X-Factor calculation must be defined as closely as possible to the unit measure on which market price is based.

42. Ad Hoc disagrees, pointing out that the ILECs' arguments support the use of minutes, not calls, since the growth in minutes is the driving force behind the ILEC's local service revenue growth. But, as Professor Gollop observes, the proper criterion for the output measure is the unit on which market price is based. In theory, a proper measure of the growth in output quantity would be a weighted average of the growth rates of physical (not deflated revenue) measures of outputs weighted by revenue shares. More weight in this measure is given to those measures of output that drive revenue. But that unit is mostly made up of lines rather than calls or minutes. The sources of local revenue reveal that more than 80% is generated from lines.[22] Moreover, in multiple regression analysis where revenue is regressed on lines, calls and minutes only lines have a statistically significant impact on revenue: changes in calls and minutes have no important impact on revenue,

[21] USTA Comments, January 7, 2000, Attachments 2 and 5.

[22] Professor Frank Gollop Comments at 21.

reflecting the flat-rate nature of most local exchange service.[23] Therefore, if one uses a single physical measure of output, it would be incorrect to use minutes as that output measure.

43. Another argument for using lines instead of calls or minutes is the fact that measures of call and minutes are more prone to measurement error. In its discussion of the quality of its measures of usage, the Commission notes that:

> Most subscribers purchase service with unlimited local calling. As a result, most calls are not metered and estimates of total calling are subject to wide margins. Periodic studies are used within the telephone industry to estimate the number of calls and calling minutes for a variety of purposes.[24]

What Ad Hoc proposes to use as the measure of physical output in a given year is not a direct observation at all but rather the result of "periodic studies" used to estimate unmetered local calling.

C. Ad Hoc's argument that hedonic changes in ILEC capital inputs give disproportionately greater weight to more recent years is unfounded

44. Ad Hoc argues (at 14) that hedonic changes in ILEC capital inputs have had the effect of bringing their prices down even further as the capabilities and capacities of individual plant components expand. Therefore, Ad Hoc claims it would be appropriate to give the greatest weight to the productivity experience of the most recent time periods. However, the Commission has already rejected any hedonic adjustments in the *1997 Price Cap Performance Review*. As stated by the Commission (¶ 67):

> We find nothing in this record to suggest that our TFP calculation would be more accurate with a hedonic adjustment. AT&T observes that its hedonic TFP adjustment results in an offsetting adjustment to its input price differential, leaving its X-Factor recommendation unchanged. In addition, neither AT&T nor Ad Hoc have shown that their hedonic adjustments accurately measure the

[23] Data for local revenue, access lines and local DEMs are taken from the Staff 1999 TFP study, Appendix B and data for calls are taken from the Commission's 1997 TFP study in the *1997 Price Cap Performance Review* and updated to 1998.

[24] Federal Communications Commission, Industry Analysis Division, *Trends in Telephone Service*, 12-1, February 1999.

> effects of technological improvements. The hedonic adjustment to the price unit of capital proposed by AT&T in its TFP model is incompletely documented, and the details on all the components of the hedonic adjustment are not clear and replicable. Ad Hoc's 10 percent per year adjustment to certain asset price indices is not supported, but stated as an assumption. Based on the record before us, there is no need to include a hedonic adjustment. [footnotes omitted].

45. There is nothing new presented by Ad Hoc to suggest that TFP growth is somehow biased if hedonic adjustments fail to be made. In fact, there are valid economic arguments why hedonic adjustments are not needed in order to estimate the appropriate X-factor. First, while it is true that there has been technological improvements in the recent past, the telecommunications industry has, for the most part, always exhibited significant technological changes. Whether it is the change from manual to electromechanical switches or the change from mechanical to analog switches, the industry is constantly improving its technology. Therefore, choosing a series at random and modifying only part of the series for unmeasured changes in the quality of output misses the fact that the earlier data that are not modified were themselves representative of superior technology *vis-à-vis* earlier periods.

46. And second, the X-factor is designed to estimate industry level unit costs. Hedonic adjustments are made in theory to reflect the fact that new equipment differs from old equipment in technology as well as in price so that adjustments must be made to avoid understating the change in the effective level of real capital stocks. But improved technology and equipment effects unit costs only in the sense that a given level of output can be produced with fewer units of inputs. Or, alternatively, a given level of output now has more bells and whistles or is of higher quality than before. The impact these changes have on TFP growth is not that the capital stock is improperly measured but rather the real impact is that output growth has been affected. Customers, observing the change in quality or options available increase their demand for the products. But this is already revealed in the output data as they exist and so no adjustment is necessary.

D. AT&T's Correction to the Staff's Imputed X Study is incorrect and reveals additional errors with the Staff Study

47. AT&T claims that its Appendix B is a technical correction to the Staff's imputed X study. According to AT&T, the staff's calculation in Table C-1 of the study improperly failed to account for the price cap "reinitialization" that occurred in July 1997[25] and, therefore, the imputed X study's X-factor for 1996 should be 6.5% rather than 5.3%. This assertion is incorrect. The same error appears in the Staff's Study which, in some instances, does not use the actual X-factors that were in place during the 1991-1995 time period but rather uses the X-factors that were used to reinitialize the PCI as a result of the *1995 Price Cap Performance Review*.[26]

48. The Staff's Imputed X study is intended to compare, *inter alia*, the actual operating revenues earned in any given year (which were produced by the *actual* X Factor in place) with the operating revenues that would have been earned under a hypothetical X Factor. Based on the hypothetical X Factor, adjustments are made to actual operating revenues. After several additional steps, a hypothetical rate of return is arrived at and compared to the Staff's erroneous "competitive" rate of return in order to determine the hypothetical X Factor that results in the price cap LEC earning a "competitive" rate of return. By not using the actual X-Factors in place during the years in question, however, the X-factors estimated by both AT&T and the Staff are biased upward. For example, when compared to the hypothetical X-factor of 6.5%, using an X-factor of 6.5% in 1996 as the actual X-factor rather than 5.3% results in a smaller revenue decrease (from imposing a higher X-factor) and, therefore, more "overearnings."[27]

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[25] In the *1997 Price Cap Performance Review*, the Commission stated (¶ 179): "[W]e require each price cap LEC to adjust its PCIs, effective July 1, 1997, to the levels for the 1997-98 tariff year that would have been in effect had we adopted the 6.5 percent X-Factor in time to become effective with the LECs' 1996 annual tariff filings."

[26] *1995 Price Cap Performance Review*, ¶ 248.

[27] As I describe at length in my initial Comments, the Staff's Imputed X-Study is theoretically unsound and inferior to the use of total factor productivity ("TFP") growth to determine the appropriate X-factor in the Commission's price cap plan primarily because it relies on jurisdictionally separated data and an interstate-only calculation makes no economic sense.

49. Thus, in addition to the fundamental flaw in the approach used by AT&T and the Staff, neither party implements the approach correctly. To compare the revenue differences that would have occurred if the X factors differed from their historical values, the X-Factor that should be used is the X-Factor that generated the actual operating revenues used by the Staff in Table C-3. In 1996, the X-factor that brought about the actual operating revenues was 5.3% not 6.5%. Similarly, for some firms in the early years of price cap regulation the X-factor that brought about the actual operating revenues is not 4.0%; rather it is 3.3%. Both the Staff and AT&T create a mismatch because the reinitializations that took place in 1995 and 1997 had no impact on LEC revenue during the years in question. As the Commission stated in the *1997 Price Cap Performance Review* (¶ 179):

> "[W]e require each price cap LEC to adjust its PCIs, effective July 1, 1997, to the levels for the 1997-98 tariff year that would have been in effect had we adopted the 6.5 percent X-Factor in time to become effective with the LECs' 1996 annual tariff filings. *This adjustment would have no effect on revenues and earnings for the 1996-97 tariff year – that is, like the adjustment upheld by the court in Bell Atlantic, the adjustment we require in this Order has no retroactive effect.*" [emphasis added].

By not using the actual X-factors that were in place during some years and which were responsible for the actual operating revenues, AT&T and the Staff Study bias their X-factor estimates upward.

V. CONCLUSIONS

50. AT&T must continue to be frustrated in its attempt to develop an economically meaningful and defensible methodology for calculating interstate-only productivity growth.[28] After nearly ten years of experience with price cap regulation and with different theoretical and practical approaches to estimating an economically appropriate X-factor, it is time to acknowledge the simple economic fact that when the production process is not separable among services, all the information in the world about interstate input and output quantities and prices is not sufficient to tell us what will happen to unit costs (and thus prices) for

[28] Nature abhors impossibility: the recent proof of Fermat's Theorem has not appeared to reduce the rate at which counterexamples are submitted to number theory web sites.

interstate services. In addition, AT&T and Ad Hoc attempt to leverage conclusions from an SPR model to measure the effect that the elimination of earnings sharing would have on productivity growth of price cap LECs. However, they fail to address the fact that any incentive is already partly included in the X-factor. Regardless, their quantification is flawed to the point of being meaningless. Their critical assumption—that doubling the economic incentive to increase profits doubles productivity growth—finds no support in the SPR Study or in common sense.[29] And their comparisons of productivity growth before and after the implementation of price caps are based on flawed measures of post price cap TFP growth.

[29] Some years ago, the Belgian government provided modest financial support to families with children. Would doubling this support be expected to double the number of families with children? Double the number of children? Produce children in 4.5 months rather than 9?